# Reference Concentration for Shelf Sediment Transport Models

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## LONG-TERM GOALS

My long-term goals are to advance understanding of sediment transport processes. In this context, the long-term goal of this project is to advance understanding of the *reference concentration,* i.e. concentration of suspended sediments at a small distance above the seafloor. The scientific interest is in relating this *reference concentration* to the forcing conditions of waves and currents. The new contribution in this effort is to observe the *reference concentration* using a new instrument MSCAT.

## OBJECTIVES

My objective within this project is to obtain field data on *reference concentration* and its variability as determined by variations in wave-current forcing conditions. Additionally, I shall characterize the size distribution and suspended velocity distribution of suspended sediments in the field.

## APPROACH

A complete suite of laser diffraction sensors were deployed for measuring the suspended particle size distribution and concentration, settling velocity distribution, and the *reference concentration* at the Santa Cruz pier in California, in water of nominally 10m depth. These measurements were made using, respectively, the LISST-100, LISST-ST and MSCAT systems. The first two of these instrument systems were developed by this PI with ONR-MG funding over the years (Agrawal & Pottsmith, 2000; Agrawal & Traykovski, 2001). These instruments are commercial products of this company now. The MSCAT is a new instrument that has just been proven in the field. The instrument suite was mounted on a tripod and the tripod was left on the seafloor for a period of 2 weeks. All instruments recorded data. Coincidentally, a powerful storm swept through the area during the latter part of the deployment (March 2003). This will provide an event for data processing.

## WORK COMPLETED

The principal work completed this year has been the full preparations and launch of a tripod at the Santa Cruz pier in California. The tripod contained LISST-100 instruments at 0.8 and 1.8meters above bed, a LISST-ST instrument that measures settling velocity at 0.8m above bed, and the MSCAT at approximately 10 cm above bed.

The deployment was co-ordinated with an instrument suite containing capability to map the velocity field, ripple field on the bed, and a 3-frequency acoustics system for sediment observations. These were managed by co-PI's David Cacchione (see this volume), and British scientist Dr. Peter Thorne.

Data processing is in progress at the time of this writing. It is the object of the present work to combine bottom stress estimates that are derived from a combination of a model and actual velocity measurements, with our measurements of suspended sediments and their settling velocities, to present an improved formulation of the *reference concentration.*

**RESULTS**

We present here the concentration and size distribution measured with the LISST and MSCAT instruments with special emphasis on a storm event.

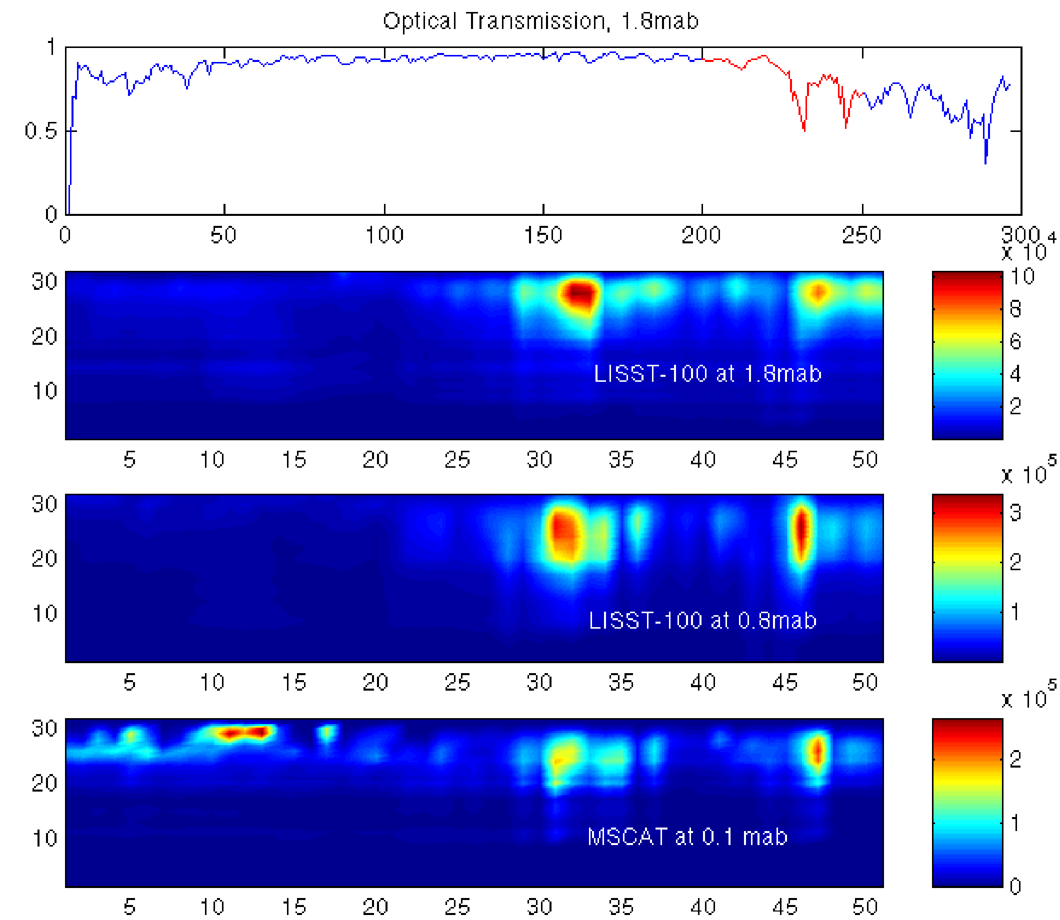


***Figure 1: Measured optical transmission on the top panel shows several blips (red) due to storm passage. Size distribution and concentration measurements during a selected period (red, top panel) are shown in lower 3 panels. The abscissa is in hours, ordinate is size-class (1.2-250 microns) and colors represent concentration.***

Measurements of size distribution at two elevations have been presented by us earlier (Agrawal and Traykovski, 2001). This is the first time that measurements of size distribution of suspended sediments at ~10 cm above bottom are being displayed. These data (bottom panel) show the appearance of large size particles (resuspended sand) that coincide with the low in optical transmission measured by one of the LISST-100's (at 1.8mab).

Details of the size distribution measured with the MSCT are shown in a single frame below.

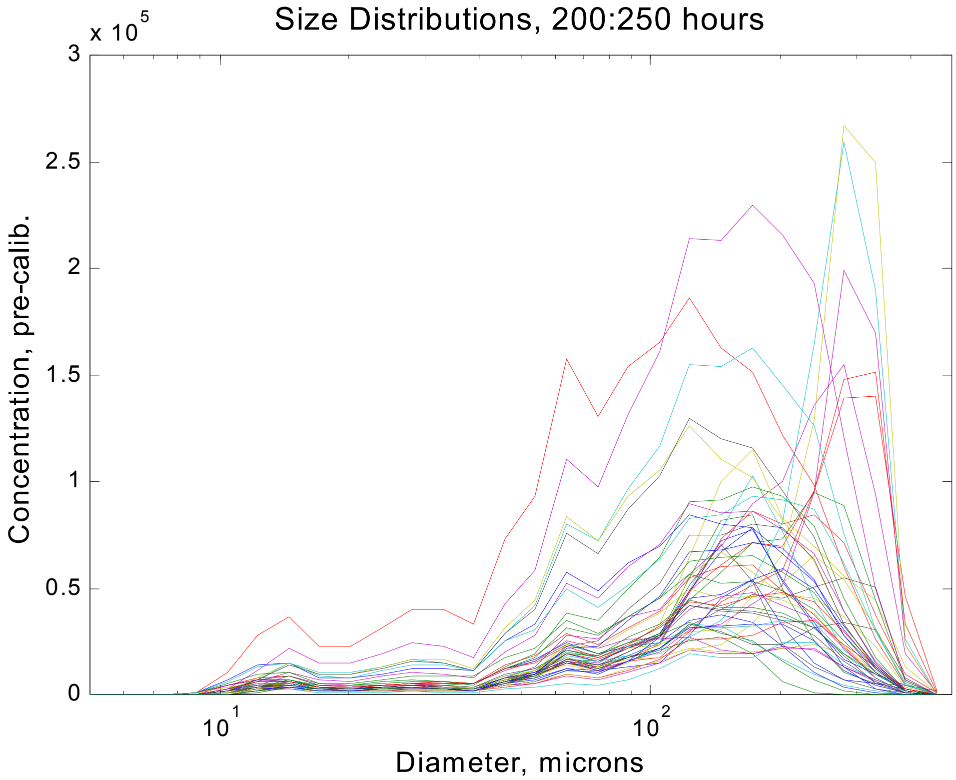


***Figure 2: Size distributions measured over 50 hours are displayed as hourly averages through a storm event. Note the appearance of larger particles is modulated during this time. Particles as large as a few hundred microns are suspended during storm events. Most of the mass in the suspended sediments is in the large particles (believed to be sand grains). The bed was coarse sand mixed with shell hash.***

Current effort is focused on combining the size distribution measurements with data on bottom stresses (Dr Cacchione) and derivation of a size-dependent estimate of the resuspension parameter $\gamma_0$. This parameter has, until now, been estimated with an uncertainly of 2-4 orders of magnitude.

## IMPACT/APPLICATIONS

The specification of the bottom boundary condition, i.e. the concentration of suspended sediments at the bottom in response to motions induced by currents and waves is one of the most fundamentally difficult and intractable problems in sediment transport. The present data will help in tightening the specifications of this *boundary condition*. Furthermore, the combined measurements of size distribution, settling velocity distribution, and reference concentration makes for a rich data set to examine established boundary layer models.

## TRANSITIONS

The data on size-distribution and settling velocity distribution is now being made available to modelers.

The newly tested MSCAT sensors will be rapidly transitioned to the scientific marketplace so that the study of *reference concentration* can become broadly driven.

During the course of this work, the PI has also stumbled on a family of shaped focal plane detectors that lead to a quantum advance in our ability to measure concentration and mean size of suspended sediments. The characteristic of these shapes is that when these detectors are placed in the focal plane of a receiving lens that collects light scattered by particles from a collimated beam, the measured concentration has a fixed calibration unlike all prior technology sensors. To emphasize, the most widely used optical backscatter sensors (OBS) are known to vary in calibration by up to a factor of 10 with color and linearly with grain size. The present development overcomes both problems. These ideas are incorporated in our new commercially available instruments.

## RELATED PROJECTS

This PI is also involved in sediment dynamics research in the ONR funded HYCODE project. In that project, temporal behavior of size distributions has been studied in the bottom boundary layer over a month long deployment. Furthermore, the entire water column was studied from a profiling LISST-100. The instruments used in the present work and HYCODE are ONR funded.

## REFERENCES

Agrawal, Y.C. and H.C. Pottsmith,(2000) : Instruments for Particle Size and Settling Velocity Observations in Sediment Transport, Marine Geology v168/1-4, pp 89-114

Agrawal, Y.C. and Traykovski, P., 2001: Particles in the bottom boundary layer, dynamics through events, Jour. Geophys. Res. v106, C5, pp 9533-9542

## PUBLICATIONS

Agrawal, Y.C. and Traykovski, P., 2001: Particles in the bottom boundary layer, dynamics through events, Jour. Geophys. Res. v106, C5, pp 9533-9542

Agrawal, Y.C. and H.C. Pottsmith, 2002: Laser Diffraction Sensors measure Concentration and Size Distribution of Suspended Sediment; *presented at* IAHS Conf. Oslo, Norway.

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